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14. ABSTRACT:
In this research training program, undergraduates in electrical and computer engineering learning the role of engineering in the cure of breast cancer, specifically, developing communications networks and imaging processing techniques for the early detection and diagnosis of breast cancer. Providing mammographic services to women in underserved areas via telemammography is very important. With remote computer-aided breast cancer detection and diagnosis, it has the advantage of higher penetration of women for cancer screening. Through this training program, the trainees learn the process of breast cancer diagnosis and the role of mammography, understand the role of wireless communications in telemammographic services.

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A Wireless Testbed Development for a Telediagnosis and Telemammography Network: An Undergraduate Summer Training Program

1. Introduction

1.1 BC-REU Research Objectives

This reports the results of our undergraduate summer training program in breast cancer research, BC-REU (breast cancer research experience for undergraduates). The focus of the research training is to develop a wireless test bed for a telediagnosis and telemammography network.

Providing mammographic services to women in underserved areas via telemammography is very important [1-3]. With remote computer-aided breast cancer detection and diagnosis, it has the advantage of higher penetration of women for cancer screening. This training program relates to research to develop a new telemammography scheme which is directed at the development, optimization, and evaluation of a new class of computer-assisted diagnostic system for telemammography applications. In the new telemammography scheme, we use Internet and wireless transmission medium to provide mammography to women in regions where physicians who specialize in diagnosing breast cancer are scarce.

Through this training program, the trainees learn the process of breast cancer diagnosis and the role of mammography; establish understanding of mammography; learn the basic principle of medical image processing; understand the role of wireless communications in telemammographic services; understand the architectures of wireless communications systems; understand the performance impact of wireless systems on telemammography [4]; and program and design elements for a wireless system/test bed.

BC-REU students together with other summer research students and faculty at Stevens.

1.2 BC-REU Team 2005 and Projects

The following table (Table 1) summarizes Year 2005's summer training team and related projects.

Table 1 BC-REU Team 2005 and Projects

Student	**Mentor**	**Project**
Ishtiaq Saeem	Dr. Hong Man	Development of audio/video remote consultation tool with Window based applications using C++ and MFC
Manish Modi		Applications of electrical engineering in the search for a cure for breast cancer
Shamin Akhtar	Dr. Uf Tureli	Comblock based test bed as applied to wireless telemammography networks
Shaina Doherty		
Tim Garner	Dr. Yu-Dong Yao	Wireless telemammography networks: Wireless channel modeling
Sheelpan Doshi	Dr. Yu-Dong Yao	Mobile Medic: Sensor, bluetooth, and cell phone for remote detection and monitoring
Christopher Alfonzo		
Jeremiah Ventry-McGee	Dr. Yu-Dong Yao	Implementation and improvement of tri-band transceiver for wireless telemammography networks

1.3 Research and Training Effort in 2006

The overall wireless test bed for wireless telemammography networks has been designed, developed, and tested during the summers of 2003, 2004, and 2005. Additional implementation and test have been conducted in 2006, including application design, integration and documentation.

2. Report Body

2.1 The Training Program

2.1.1 Training Program Overview

In the summer of 2005, we ran our third-year training program under this award/funding support. The program/activities are designed heavily based on our previous programs in the summers of 2003 and 2004. Eight undergraduate students participate in the training program. There are 4 mentors (Profs. H. Man, U. Tureli, W. Qian, and Y. D. Yao). Additionally, there are two graduate students (Hanyu Li and Mubashir Syed) interacted with and advised the undergraduate trainees. The undergraduates participated in six projects (see subsection 2.2.2).

	
Orientation/welcome meeting.	Welcome lunch.

2.1.2 Training Elements

This 12-week training program is organized and scheduled into 12 units. There are learning elements (Java programming, socket programming, C++, and GUI designs) and laboratory assignments (electronic components selection and testing) for each unit. There are presentations and seminars by mentors. Another important element of the training program is the weekly all-hands meetings.

2.1.3 Weekly Meetings

There are weekly all-hands meetings for trainees to report work progress and plans for the following week. Mentors, graduate students and undergraduate trainees have extensive interactions through the weekly meetings. Students also gain experiences in presentations and professional communication. Students set up personal research web page and post their weekly reports and research documents.

	
Weekly meeting/report/presentation (Manish Modi)	Weekly meeting/report/presentation (Ishtiaq Saeem)
	
Weekly meeting/report/presentation (Shamin Akhtar)	Weekly meeting/report/presentation (Jeremiah Ventry-McGee)

2.1.4 Seminars

During the research and training program, several seminars are given by students and faculty.

BC-REU student Manish Modi gave a seminar on searching for a cure for breast cancer.

BC-REU student Jeremiah Ventry-McGee gave a seminar on telehealth and remote monitoring.

Students attending a seminar on breast cancer given by Prof. W. Qian.

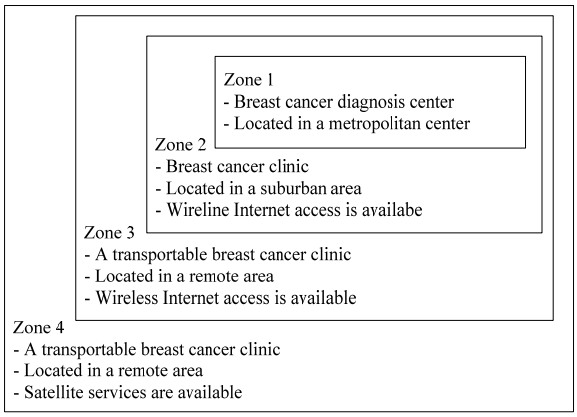
2.1.5 Mentor Involvement

Faculty members (Dr. Yu-Dong Yao, Dr. Hong Man, Dr. Uf Tureli, and Dr. Wei Qian) interacted with students frequently. A number of graduate students worked with the undergraduates in a team and contributed significantly to the training program. Faculty mentors and undergraduate trainees attend weekly all-hands meetings. Such a group setting serves an important mentoring process. Additionally, faculty mentors visit the trainees in the research laboratory at least once a week, thus ensuring individual mentorship (mentor-trainee) once a week.

2.2 Study and Research Areas

2.2.1 Test Bed and Telemammography Network Architecture

A telehealth network architecture was first developed in the Summers of 2003 and 2004. As shown in Figure 1, there are four service zones in a wireless telemammography network. Zone 1 represents a breast cancer diagnosis center which is located in a metropolitan center and serves as a central hub performing functions such as patient on-site screening, remote telescreening, telediagnosis, teleconsultation, and tele-education. Storage and processing of patients' records are also the responsibility of Zone 1. High-speed Internet access is available to connect with other Zone 1 centers and remote clinics. Remote breast cancer clinics located in suburban areas are considered to be in Zone 2 where high-speed Internet access is available. Connecting to Zone 1 through Internet, telescreening can be conducted for patients. For remote areas, we may consider transportable breast cancer clinics which connect to breast cancer diagnosis center (Zone 1) through wireless Internet to perform telescreening. This is classified as Zone 3. One of the tasks in the research is to develop schemes to transport multimedia applications (such as remote telescreening, telediagnosis, teleconsultation, and tele-education) through wireless communications channels. Zone 4 is the same as Zone 3 with the exception that terrestrial wireless access is not available. We thus need to reply on satellite systems to act as the transmission media in Zone 4. It is seen that a wireless transmission entity is in the center of the network. The summer training program focuses on the development of software packages to provide teleconferencing capability between the remote site and the central office and the development of radio frequency transceiver.



Telehealth network architecture

2.2.2 Projects

The following lists six projects conducted in the summer program.

(1) Development of audio/video remote consultation tool with Window based applications using C++ and MFC: Development of an interactive and multimedia platform for remote consultation and diagnosis of breast cancer.

(2) Applications of electrical engineering in the search for a cure for breast cancer: Investigation of various systems, techniques, and methodologies which can be applied to breast cancer research.

(3) Comblock based test bed as applied to wireless telemammography networks: Design, implementation and integration of wireless network test bed using Comblock modules. Module programming and testing of the test bed performance.

(4) Wireless telemammography networks: Wireless channel modeling: Investigation of wireless channel models for the evaluation of wireless networks as applied to telemammography networks.

(5) Mobile Medic: Sensor, bluetooth, and cell phone for remote detection and monitoring: Investigation and development of handheld devices and user interfaces for remote monitoring, detection and consultation between end users and central hospitals.

(6) Implementation and improvement of tri-band transceiver for wireless telemammography networks: Circuits design and implementation of wireless test bed for wireless telemammography networks.

2.2.3 Telehealth Video Conference Program for Remote Detection and Diagnosis of Breast Cancer

In a world where medical expertise may be limited, the TeleHealth Med Conferencer is real solution that can help bring experts to the battle front. With further development of this program, medical expertise will be able to be brought anywhere in the world. Currently the software is a windows based teleconferencing program that incorporates a whiteboard application. The optimal product would be a cross platform program that ould work on both Windows and Linux and would provide features such as audio/video chat, a whiteboard, and an ftp client. The whiteboard was to incorporate a code that would detect microcalcifications in mammograms to help doctors detect Breast Cancer.

The technologies that needed to be researched included creating GUIs in C++, developing an FTP Client, and Video technologies. Several tasks performed are (1) Choosing an operating system; (2) Choosing a programming language; (3) Developing a GUI in C++; and (4) Developing video conferencing (Open CV and OpenH323).

2.2.4 Applications of Electrical Engineering in the Search for a Cure for Breast Cancer:

As Electrical Engineers, we can find better methods of detection that can lead to earlier diagnosis of the disease, and use our knowledge of electricity to provide better equipment to remove malignant cancer spots. Currently EE's are applying themselves to work for a world without this disease, by dedicating time to research Ultra-Wideband Microwave Imaging, Space-Time Beamforming, Automated Target Recognition, and the application of wavelets to Mammograms to name a few.

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Google: Breast cancer detection; (1) Improving Methods for Breast Cancer Detection and Diagnosis, http://cis.nci.nih.gov/fact/5_14.htm; (2) Breast Cancer: Steps to Finding Breast Lumps Early, http://familydoctor.org/018.xml; (3) Mammograms: A consumer guide to breast cancer detection, http://www.nclnet.org/mammogram.htm.

3. Key Research Accomplishments

- A telehealth and telediagnosis network architecture (Figure 1) was defined, with applications to telemammography
- A software package providing telehealth video conference program for remote detection and diagnosis of breast cancer

4. Reportable Outcomes

- Developed a software package providing telehealth video conference program for remote detection and diagnosis of breast cancer, which includes the features of audio, video, text, and whiteboard.

- A paper presented at a conference: Y. D. Yao, N. Kumar, and W. Qian, "Software Defined Radio and Communication Networks for Telehealth Applications," IASTED International Conference on Telehealth, Banff, Canada, July 19-21, 2005.

5. Conclusions

This training program has given undergraduate students good opportunities to understand the importance of mammography and telemammography. It shows engineering students (electrical and computer engineering) the role of engineering and technology in health care and medical services. The training program also enables the undergraduate students interact with faculty and graduate students in learning and research. The Summer 2005 program, built upon the results of 2003 and 2004, results in a wireless and multimedia network test bed for applications in telemammography. The overall test bed was further developed and finalized in 2006.

6. References

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